

-a-

LD11591

APPLICATION FOR UNITED STATES PATENT

OUTER SEALS FOR SHRINK-SEALED  
METAL HALIDE ARC TUBES

Applicants: Mark E. Duffy  
Christina K. Clement  
Eugene A. Smith

March 26, 2001

1           OUTER SEALS FOR SHRINK-SEALED METAL HALIDE ARC TUBES

2       FIELD OF THE INVENTION

3           The invention relates to a method of making metal halide  
4       arc tubes, more specifically arc tubes for use in metal halide  
5       arc lamps

6       BACKGROUND OF THE INVENTION

7           Shrink sealing refers to the process of making metal  
8       halide arc tubes and lamps without the use of a separate  
9       exhaust tube for pressurizing and depressurizing the tube and  
10      for inserting vaporizable doses of mercury and halide  
11      compounds. For each seal, the arc tube body material,  
12      typically quartz, is given an internal pressure lower than the  
13      ambient atmospheric pressure and is then heated and allowed to  
14      shrink down on an electrode assembly, thus capturing the  
15      electrode in the desired position.

16          Typically the mercury and halide doses are inserted, and  
17      then a shrink seal is formed near the midsection containing  
18      the doses. Formation of the shrink seal near the newly  
19      inserted doses may cause them to vaporize and contaminate the  
20      vacuum system. It would be desirable to minimize the  
21      possibility of halide vaporization and resultant contamination  
22      of the vacuum system. Another contamination problem may arise  
23      if hydrocarbons from the vacuum system enter the arc tube body  
24      and interfere with the subsequent function of the lamp. It  
25      would thus be desirable to minimize the possibility of  
26      hydrocarbon contamination of the arc tube body from the vacuum  
27      system.

28          After the halide doses and electrodes are sealed in  
29      place, a reflective coating is often applied to the exterior  
30      of the arc tube body. The electrode leads should be protected  
31      during application of the coating so as to remain unfouled.

32      SUMMARY OF THE INVENTION

33      A method of producing a metal halide arc tube is provided.  
34      The method comprises the steps of providing an arc tube body

1 having first and second ends; inserting a first electrode  
2 assembly and a second electrode assembly into the arc tube  
3 body, and creating first, second, third and fourth seals in  
4 the arc tube body. Each seal is formed by heating the arc  
5 tube body at a desired location while maintaining a gas  
6 pressure inside the arc tube body lower than the pressure  
7 outside the arc tube body. A first portion including the  
8 first end and one of the seals is removed, and a second  
9 portion including the second end and another of the seals is  
10 removed.

#### 11 BRIEF DESCRIPTION OF THE DRAWINGS

12 Fig. 1 is an elevation of an arc tube body following  
13 insertion of electrodes.

14 Fig. 2 is an elevation of an arc tube body following  
15 creation of a first seal between an electrode and an outer end  
16 of an arm of the arc tube body.

17 Fig. 3 is an elevation of an arc tube body following  
18 creation of a second seal encompassing an electrode.

19 Fig. 4 is an elevation of an arc tube body following  
20 insertion of mercury and halide doses and creation of a third  
21 seal between an electrode and an outer end of an arm of the  
22 arc tube body.

23 Fig. 5 is an elevation of an arc tube body following  
24 creation of a fourth seal encompassing an electrode.

25 Fig. 6 is an elevation of an arc tube body following  
26 application of a coating.

27 Fig. 7 is an elevation of an arc tube body following  
28 removal of the outer parts of the arms and trimming of the  
29 electrode assembly leads.

#### 30 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE 31 INVENTION

32 In the description that follows and in the claims, when a  
33 preferred range, such as 5-25, is given, this means preferably  
34 at least 5, and separately and independently, preferably not  
35 more than 25.

1 Referring to Fig. 1, an aspect of the method according to  
2 the invention begins with the provision of a pre-formed quartz  
3 arc tube body 10 having a bulbous midsection 12 and two arms  
4 14, 16, each projecting in opposite directions from the  
5 midsection. Each arm has an outer end 15, 17. The arc tube  
6 body is seized in the headstock and tailstock of a lathe (not  
7 shown) having the capacity to rotate the arc tube body on its  
8 axis, evacuate the arc tube body, apply heat sufficient to  
9 melt the arc tube body, and supply appropriate fill gases to  
10 the arc tube body. Electrode assemblies 18, 20 are inserted  
11 into the arc tube body. Each electrode assembly has a  
12 molybdenum foil 32, a spring clip 34 attached to the foil, a  
13 tungsten shank 36 attached to the molybdenum foil, and a coil  
14 38 attached to the tip of the shank. The spring clip and  
15 shank each project in opposite directions from the foil. Each  
16 electrode assembly is positioned in an arm with its spring  
17 clip projecting toward the outer end of the arm. The  
18 electrode assemblies are placed in the arc tube body so that  
19 the space between the coils is in the arc chamber 13,  
20 preferably defined by the bulbous midsection 12, and the  
21 distance between the coils is appropriate for the size and  
22 rating of the lamp. The arc chamber is preferably essentially  
23 centrally located in the arc tube body, between the electrode  
24 assemblies. The spring clip serves to temporarily hold the  
25 electrode assembly in place until the electrode assembly is  
26 sealed in place in the arc tube body.

27 Referring to Fig. 2, a first seal 42 is made by  
28 simultaneously rotating, evacuating, and heating the tube  
29 until the quartz melts and collapses. This seal is made,  
30 preferably between the molybdenum foil 32 of electrode  
31 assembly 18 and the adjacent outer end 15 of the arm 14 seized  
32 in the tailstock of the lathe, more preferably between the  
33 electrode assembly 18 and the adjacent outer end 15 of the arm  
34 14 seized in the tailstock of the lathe. A vacuum is drawn  
35 from a tail stock pump while the head stock is blanked off.  
36 After this first seal is formed the interior of the arc tube

1 body is protected from contaminants originating from the tail  
2 stock vacuum system.

3 Referring to Fig. 3, a second seal 44 is formed to  
4 encompass a central portion of electrode assembly 18,  
5 preferably at the foil 32 of the electrode assembly 18, in the  
6 same arm 14 as the first seal 42. Forming a seal at a central  
7 portion of the electrode assembly such as the molybdenum foil  
8 ensures that part of the electrode assembly will extend from  
9 each side of the seal, allowing passage of electricity through  
10 the seal via the electrode assembly. The second seal is also  
11 formed by rotating, evacuating and heating the tube until the  
12 quartz melts and collapses. The vacuum is drawn from the  
13 headstock through outer end 17 during the formation of the  
14 second seal. Following the formation of the second seal,  
15 doses of halide compound 46 and of mercury 48 are inserted  
16 into the arc chamber, as shown in Fig. 4. The halide doses  
17 typically comprise a mixture of the bromides or iodides of  
18 sodium, scandium, and thorium, but may contain any of the  
19 commonly used halides for high intensity discharge lamps.  
20 These include iodides and bromides of thallium, dysprosium,  
21 holmium, thulium, cerium, cesium, and calcium.

22 The insertion of the doses is generally performed with  
23 the assistance of gravity without moving the already-  
24 positioned electrode assemblies. This is best done by placing  
25 the arc tube body with its long axis in a vertical position  
26 with the open arm facing upward, and then releasing the doses  
27 into the arc tube body from a position above the electrode.  
28 Even if the doses strike the electrode assembly, they will  
29 generally move downward past the assembly and into the bulbous  
30 midsection without substantially changing the position of  
31 either electrode assembly. This is important, as any  
32 substantial change in the position of the electrode assembly  
33 which would require repositioning of the electrode assembly to  
34 ensure proper function of the arc tube. The use of a small  
35 halide pellet allows sufficient clearance for the pellet to  
36 move past the electrode. The doses can be introduced  
37 separately, or in combination.

1           Following insertion of the doses, the arc tube body is  
2 re-pressurized with a fill gas through outer end 17. Typical  
3 fill gases are argon, krypton, xenon, or mixtures thereof.  
4 Typical fill gas pressures are 20-500 torr.

5           It is desirable to maintain sub-atmospheric pressure in  
6 the arc tube body during the formation of the seals. During  
7 operation of the lamp the temperature and pressure of the fill  
8 gas will rise. Nevertheless, if a higher operating pressure  
9 is desired than can be provided by introducing a  
10 subatmospheric gas fill at ambient temperature, then the arc  
11 tube body, the gas fill, or both may be cooled during  
12 pressurization. This will allow more gas to be introduced  
13 into the arc tube body, while maintaining sub-atmospheric gas  
14 pressure in the arc tube body during manufacture.

15           Following insertion of the doses and pressurization, a  
16 third seal 50 is made, preferably between the molybdenum foil  
17 32 of electrode assembly 20 and the outer end 17 of the arm  
18 16, more preferably between the electrode assembly 20 and the  
19 outer end 17 of the arm 16. This seal is also made by heating  
20 and rotating the arc tube body along its axis. Because the  
21 pressure in the arc tube body is less than the ambient  
22 pressure, the quartz will collapse to form the seal when  
23 heated. By making the seal 50 at a distance from the arc  
24 chamber 13, rather than at foil 20, less heat is transferred  
25 to the halide doses 46 and vaporization of the halide doses is  
26 reduced or avoided. Thus contamination of the headstock by  
27 halide vapor escaping through outer end 17 is also reduced or  
28 avoided.

29           Referring to Fig. 5, a fourth seal 52 is made at a  
30 central portion of the electrode assembly 32, preferably at  
31 the foil 32 of the electrode assembly 20 in the same arm 16 as  
32 the third seal 50. This seal is also formed by rotating and  
33 heating the tube until the quartz melts and collapses. The  
34 sub-atmospheric pressure of the fill gas in the arc tube body  
35 will result in the quartz tube collapsing when softened by  
36 heating, as it did during formation of the third seal. As  
37 with formation of the third seal, cooling of the tube may be

1 necessary to maintain the gas pressure in the arc tube body  
2 below ambient pressure.

3 Following formation of the fourth seal, an outer coating  
4 may be applied to the arc tube body. Outer coatings are  
5 generally used to reflect infrared radiation back into the arc  
6 chamber. This helps to ensure that a sufficiently high  
7 temperature is maintained on the interior of the arc chamber.  
8 Typically the central portion of the bulbous midsection will  
9 be masked off to prevent deposition of the coating in that  
10 region. In Fig. 6, an arc tube body 10 is shown with a  
11 coating 54 substantially covering the surface except for a  
12 central portion of the bulbous midsection 12. The coating is  
13 typically a single or multiple layer thin film of an alumina  
14 material, although other known coatings such as zirconia,  
15 tantala, silica, titania, or combinations thereof may be used.  
16 Seals 42 and 50 ensure that the coating is not deposited on  
17 spring clips 34 of electrode assemblies 18 and 20.

18 After the coating is deposited on the arc tube body, the  
19 ends of the arc tube body are removed, resulting in an arc  
20 tube body with two seals and two outer ends 60, 62. The  
21 spring clips 34 are trimmed, leaving two electrode leads 56,  
22 58 for connection to a source of electrical energy. By  
23 following this procedure, contamination of the leads by the  
24 coating process is avoided.

25 While the invention has been described with reference to  
26 a preferred embodiment, it will be understood by those skilled  
27 in the art that various changes may be made and equivalents  
28 may be substituted for elements thereof without departing from  
29 the scope of the invention. In addition, many modifications  
30 may be made to adapt a particular situation or material to the  
31 teachings of the invention without departing from the  
32 essential scope thereof. Therefore, it is intended that the  
33 invention not be limited to the particular embodiment  
34 disclosed as the best mode contemplated for carrying out this  
35 invention, but that the invention will include all embodiments  
36 falling within the scope of the appended claims.